

CLAIMS

WHAT IS CLAIMED IS:

1. A method of operating a blood pump, comprising:
sampling a time continuous signal from the blood pump;
5 transforming the sampled time continuous signal to the frequency domain;
analyzing the sampled time continuous signal in the frequency domain;
controlling the blood pump in response to the analysis of the sampled time
continuous signal in the frequency domain; and
detecting excess suction in response to the analysis of the sampled time continuous
10 signal in the frequency domain;
2. The method of claim 1, further comprising determining parametric data in
response to the analysis of the sampled time continuous signal in the frequency domain.
3. The method of claim 2, wherein the parametric data include heart rate.
4. The method of claim 3, further comprising zero padding the time
15 continuous signal.
5. The method of claim 4, wherein sampling the time continuous signal from
the blood pump includes sampling less than about 200 data points of the time continuous
signal.
6. The method of claim 5, further comprising zero padding at least about
20 3800 data points.

7. The method of claim 2, wherein the parametric data include respiratory rate.

8. The method of claim 2, wherein the parametric data include pump flow rate.

5 9. The method of claim 1, further comprising validating the sampled time continuous signal in response to the analysis of the sampled time continuous signal in the frequency domain.

10 10. The method of claim 9, wherein validating the sampled time continuous signal includes evaluating the signal to noise ratio.

11 11. The method of claim 9, wherein validating the sampled time continuous signal includes evaluating the signal to noise plus distortion ratio.

12. The method of claim 1, wherein the time continuous signal comprises the pump flow rate.

13. The method of claim 1, wherein the time continuous signal comprises the pump speed.

14. The method of claim 1, wherein the time continuous signal comprises the pump current.

15 15. A blood pump control system, comprising:
a processor receiving a time continuous signal from the blood pump system;

the processor being programmed to transform the time continuous signal to the frequency domain, and control the blood pump and detect excess suction in response to the time continuous signal in the frequency domain.

16. The system of claim 15, wherein the processor is further programmed to
5 determine parametric data based on the sampled time continuous signal in the frequency domain, the processor including an output terminal for outputting the parametric data.

17. The system of claim 15, wherein the processor is programmed to validate the sampled time continuous signal based on the sampled time continuous signal in the frequency domain.

10 18. The system of claim 17, wherein the processor is programmed to calculate the signal to noise ratio.

19. The system of claim 17, wherein the processor is programmed to calculate the signal to noise plus distortion ratio.

20. The system of claim 15, wherein the blood pump system includes a pump
15 and flow measurement device measuring the pump flow rate, and wherein the processor is connected to the flow measurement device to receive a signal indicating the pump flow rate.

21. The system of claim 15, wherein the blood pump system includes a pump,
and wherein the processor is connected to the pump to receive a signal indicating the
20 pump speed.

22. The system of claim 15, wherein the blood pump system includes a pump, and wherein the processor is connected to the pump to receive a signal indicating the pump current.

23. The system of claim 15, further comprising:
5 an analog to digital converter that converts the time continuous signal to a digital signal; and
a sample mode selector connected to the analog to digital converter, the sample mode selector setting one of a synchronous sample mode or an asynchronous sample mode, wherein
10 if the asynchronous sample mode is set, the sampling rate of the analog to digital converter is set by a reference clock; and
if the synchronous sample mode is set, the sampling rate of the analog to digital converter is set according to the frequency of the time continuous signal.

24. A blood pump system, comprising:
15 a blood pump including a motor having a rotor and a stator, the stator including a plurality of stator windings;
a motor controller coupled to the motor;
a processor having inputs coupled to the motor controller for receiving a time continuous signal from the pump;
20 the processor being programmed to transform the time continuous signal to the frequency domain, and control the pump and detect excess suction in response to the time continuous signal in the frequency domain.

25. The blood pump system of claim 24, wherein the motor controller applies current to the stator windings in a sequence to create a rotating field, and wherein the time continuous signal includes the stator winding current.

26. The blood pump system of claim 24, further comprising a flow measurement device coupled to the processor for providing a signal representing the pump flow rate, wherein the time continuous signal includes the pump flow rate.

27. The blood pump system of claim 24, wherein the processor is programmed to zero pad the received time continuous signal.

28. The blood pump system of claim 27, wherein the received time continuous signal from the blood pump comprises less than about 200 sampled data points of the time continuous signal.

29. The blood pump system of claim 28, wherein the processor is programmed to zero pad at least about 3800 data points.

30. A method of determining heart rate, comprising:
sampling a time continuous signal from a blood pump at a predetermined sampling frequency for a predetermined time period to obtain a sample N;
zero padding the sampled time continuous signal to achieve a sample M, where M is greater than N;
transforming the zero padded time continuous signal to the frequency domain; and
determining a heart rate based on the frequency domain representation.

31. The method of claim 30, wherein the frequency domain representation of the zero padded time continuous signal comprises a spectral peak at a frequency proportional to the heart rate.